Arctic Mixed-Phase Cloud Dissipation and its Relationship to Low CCN Concentrations

Lucas Sterzinger, Adele L. Igel

Atmospheric Science Graduate Group
Department of Land, Air, and Water Resources - University of California, Davis

Overview

Can a lack of environmental CCN/aerosol be a primary factor for Arctic cloud dissipation?

- Persistent mixed-phase boundary layer clouds are important regulators for Arctic (and global) climate.
- Accurately modeling Arctic clouds are important to properly simulate the global climate system.
- Unlike in lower latitudes, Arctic aerosol concentrations have been hypothesized to be low enough to inhibit cloud formation
  - Mauritsen et al. (2011) coined the term "tenuous clouds" in which cloud structure was limited by aerosol concentration

Simulation Setup

Regional Atmospheric Modeling System (RAMS) in LES mode

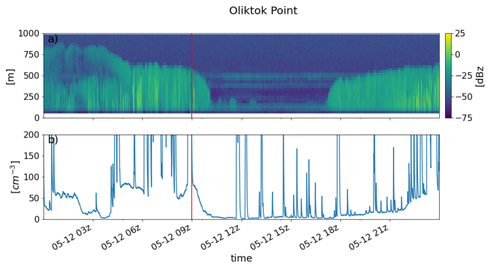
- Harrington 2-stream radiation
- RAMS 2M bulk microphysics
- Prescribed aerosol concentration

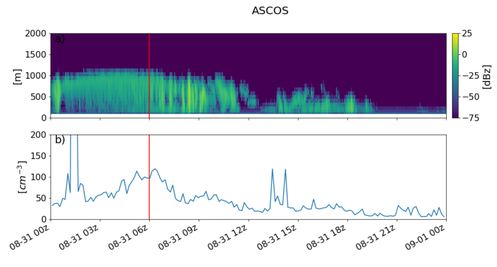
Cases

Two potential cases have been identified where cloud dissipation occurred coincidentally with a surface aerosol concentration decrease:

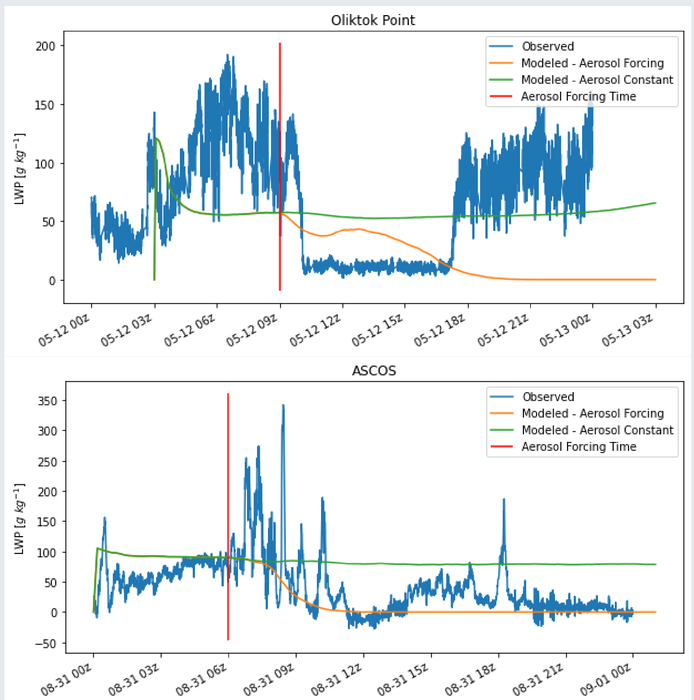
- Oliktok Point - May 12th, 2017 - Northern slope of Alaska - ocean/land boundary
- ASCOS - August 31st, 2008 - Arctic ocean ice floe

The plots below show radar reflectivity (a) and aerosol concentration (b).





Simulation Results



Balloon soundings and observed aerosol concentrations used to initialize LES model

Two simulations per case:

- Stable-cloud control
  - Aerosol concentration held constant throughout, no source/sink
- Aerosol Forcing Experiment
  - Same as control, but aerosol forced to 0 cm^{-3} at the time denoted by the red line

Compare LWP response to aerosol forcing against observed LWP at time of cloud dissipation.

Discussion

The extreme forcing simulations were done to ascertain whether or not aerosol-limited dissipation could be the cause of the observed dissipation cases. Ideally, these extreme aerosol forcings should

- If the modeled LWP response was slower than the observed, then other effects must be enhancing the dissipation rate
- If modeled LWP response was faster than observed, limited aerosol may be the primary cause of dissipation, but is not possible to say for certain

Main Takeaways

- The Oliktok Point simulated LWP response was much slower than observed, indicating that other factors were likely forcing the cloud disspiation
- The ASCOS simulated LWP response matched closely with the observed decay, suggesting that the ASCOS case may have dissipated due to lack of aerosol